Decision Making and Memory Function as Predictors of Self-Care in Patients with Heart Failure

Senior Undergraduate Thesis

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by

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Abstract

Heart Failure (HF) is a chronic illness that impairs the heart's ejection fraction, leading to the inability to provide sufficient oxygenated blood to essential organs. Due to this, patients with HF may exhibit deficits in memory function, decision-making, and self-care. The purpose of this study was to examine two areas of working memory function (i.e., immediate and delayed recall) and decision-making, in relation to age and self-care in patients with HF. Additionally, it was to investigate memory function as a moderator between decision-making and self-care. Especially since maintenance, management, and confidence in self-care abilities may be important for alleviating a patient's HF symptoms.

The data used in this project came from a current and more extensive intervention study for heart failure patients who experience insomnia. The Brief Behavioral Treatment for Insomnia (BBTI) sample included 23 patients (75% women, 65% white), the average participant age was 55.7 years (SD = 11.3) and ranged from 36 to 77 years old. Participants were recruited from inpatient and outpatient HF clinics at Ohio State; including the Ross Heart Failure Clinic and OSU Outpatient Care East. This study utilized data from the baseline assessment, to measure the following domains: immediate and delayed memory (Verbal Paired Associates I and II), heart failure self-care (Self-care of Heart Failure Index (SCHFI)), and risky decision making (Game of Dice Task (GDT), Monetary Choice Questionnaire (MCQ), and the Iowa Gambling Task (IGT)).

Results did not support a significant relationship between decision-making and self-care ($r = 0.33$, $p = 0.12$), age and self-care ($r = -0.26$, $p = 0.22$), short-term memory and self-care ($r = 0.35$, $p = 0.11$), and long-term memory and self-care ($r = 0.32$, $p = 0.13$). Twelve moderated

multiple regressions were performed to investigate the influence of memory function on the relationship of decision-making and self-care. A trending interaction supported ($F(3,19) = 2.95$, $p = 0.06$, $R^2 = 0.32$) that riskier decision-making was associated with lower self-care in the presence of poorer delayed recall. In conclusion, in the presence of poorer memory function risky decision-making is more strongly associated with poorer self-care in patients with heart failure. Since heart-failure patients experience an exacerbated decrease in decision-making abilities when poor memory function is existent, they are often unable to engage in self-care practices such as maintaining a low-sodium diet or having a consistent sleep schedule. This can possibly exacerbate heart-failure related symptoms. Ultimately, an intervention would be needed to further resolve the memory function issue, consequently leading to better decision abilities and self-care management, maintenance and confidence.

Introduction

Heart Failure

Heart failure (HF) is a chronic condition in which the functioning of the heart's ventricles is impaired, leading to a reduction in the supply of oxygen- and nutrient-rich blood throughout the body. This heart related insufficiency can result in a variety of symptoms, including fatigue, difficulty concentrating, edema, exercise intolerance, and shortness of breath. Correspondingly, heart failure is one of the leading causes of hospitalization, morbidity, and sudden mortality in the United States, predominantly among vulnerable populations ages 65 or older (Watson, Gibbs, and Lip, 2000; Roger, 2013).

This condition impairs the lives of 5.7 million individuals in the United States, and 26 million worldwide (Benjamin et al., 2017; Mozzafarian, 2016). Patients normally experience debilitating symptoms that often lead to hospitalization and account for 50% of healthcare costs related to HF in both the United States and Europe (Roger et al., 2012). Despite advances in prognosis, re-admission rates remain high: approximately 24% of HF patients are readmitted at 30 days, 30% at 60 to 90 days post-discharge, and ≥ 50% within 6 months (Ross et al., 2010; Fonarow et al., 2007; Desai and Stevenson, 2012; Butler and Kalogeropoulos, 2008). Nevertheless, patients can diminish the probability of hospitalization by 50% through the execution of self-care behaviors (Bennet et al., 1998; Braunstein et al., 2003).

Furthermore, the heart is able to compensate by maintaining physiological processes like regulating the blood pressure to help with circulation and oxygen-delivery to essential organs. However, it can only do so temporarily. HF is a progressive and chronic condition that worsens

with age (Roger, 2013). Once these homeostatic mechanisms are no longer practical, the magnitude of reduced blood flow (ischemia) or reduced blood oxygen (hypoxia) can affect the working ability of organs like the brain (Bhaswati et al. 2017). Evidence suggests that decreased regional cerebral blood flow (CBF) in HF patients can contribute to tissue injury in affected areas and result in cognitive deficits (Bhaswati et al., 2017). Bhaswati and colleagues (2017), found that HF patients showed decreased responsiveness of the hippocampus and prefrontal cortex, which are highly associated with the regulation of short-term memory (STM) and decision-making functions (DM). Psychological comorbidities such as cognitive dysfunction and loss of intellectual function can interfere with the daily functioning of patients with HF (Cohen and Mather, 2007).

Heart failure patients must care for their health through engaging in exercise, and self-care maintenance and management. Nevertheless, it is reported that 38% of patients with HF die within one year of their diagnosis; meanwhile, 60% of the patients will die within five years (Barclay, Case-Upton, Kuhn, and Smith, 2011). Although HF is a chronic condition with debilitating symptoms, self-care behaviors can be used to manage disease progression, re-admission to hospitals, regulation of symptoms, and maintenance of a healthy lifestyle. Health professionals recommend reducing sodium intake, bodyweight management, healthy eating habits, engaging in moderate physical activity, reducing stress, and maintaining a consistent sleep schedule (National Heart, Blood, Lung Institute, 2015). Medical professionals are required to educate their patients regarding these lifestyle practices; however, it is ultimately the patient's decision to engage in adequate self-care management.

Cognitive Function in Heart Failure

Cognitive impairment is one of the most common comorbid conditions among elderly patients with HF (Harkness et al., 2011). Since HF incidence increases with age, the geriatric cohort should be taken into account when assessing cognitive impairment. Eight out of ten patients with HF are more than 65 years old, and they are four times more likely to have a decrease in cognitive function than healthy individuals (Sauvé et al., 2009). Cognitive function includes abilities such as working memory, executive control and decision-making.

Memory-based decision-making applies to the maintenance and adherence of self-care behaviors in patients with heart failure. While patients are able to comprehend these new behaviors, they must be able to recall the information before deciding whether they will indeed include it in their daily routine. About 25% to 50% of heart failure patients experience executive impairment, which accounts for the decline in effective memory performance (Pressler, 2008; Sauvé et al., 2009; Zuccalá et al., 2005). These deficits are believed to be an outcome of chronic cerebral hypoperfusion (Efthimios et al., 2012).

Prefrontal Cortex and Cerebral Blood Flow in Heart Failure

The pathophysiology behind functional and anatomical changes in the brain relies on the heart pumping sufficient oxygenated blood, with the brain blood supply relying on carotid and vertebral arteries. Depending on which area of the brain experiences reduced CBF, different executive functions may be impaired.

The prefrontal cortex (PFC) plays a critical role in numerous forms of cost-benefit decision making (Orsini et al., 2018). However, it is common for HF patients to experience a

change in cerebral blood flow that often results in changes in brain neural activity, or impaired cerebrovascular reactivity (Roy et al., 2017). Accordingly, hypoperfusion in the PFC may account for a decline in decision-making executive functions, which may impede important self-care behaviors (Roy et al., 2017). Hypoperfusion in the hippocampus and corpus callosum affected short-term memory and verbal memory functions (Roy et al., 2017).

Decision-Making

The decision-making process can be defined as the selection of a choice or action among two or more alternatives to arrive at a solution that is beneficial over a long time (Suhr and Buelow, 2009). Heart failure patients face simple and complex decisions ranging from daily self-care management (exercise, body weight, and food intake) to reasoning through the benefits and disadvantages of various possible interventions, such as implant cardiac defibrillators, mechanical circulatory support or deciding to have a heart transplant during their treatment (Hamel et al., 2018). When the decision-making process is disrupted, an individual may be more likely to engage in risky decision-making. Disruption of this process can come from increased stress (Ceccato, Kudielka, and Schwieren, 2016), depressed emotions (Suhr and Tsanadis, 2007), and prefrontal cortex brain damage from ischemia, or reduced blood flow (Spaniol et al., 2018).

Heart failure patients are often forced to make health-related decisions daily due to symptom exacerbations, worsening overall health, and a change in their heart-failure related treatment (Xu, Abshire and Han, 2015). Furthermore, effective self-care procedures require patients to make regular decisions related to medication adherence, sodium intake, and exercise. Future long-term decisions also can be frightening because patients with HF may need to decide

whether or not to be resuscitated, and when to deactivate their cardioverter defibrillator (Xu, Abshire, and Han, 2015).

According to a study conducted by Xu, Abshire, and Han (2017), patients who did not want to be resuscitated (DNR) were more likely to be older and had more prolonged hospitalizations. Further, the disruption of this decision-making process can occur because of unpredictable reasons, including depression and anxiety. Among independent community-dwelling patients with HF, Almeida et al. (2001) found that these heart failure patients had gray matter loss in the anterior cingulate cortex (ACC), and lateral and medial prefrontal cortex (mPFC), reflect areas important for executive function. The ACC is responsible for strategic thinking, and it connects the emotional area of the limbic system to the cognitive area of the prefrontal cortex (Stevens et al., 2011).

Further, the lateral and medial prefrontal cortex plays a substantial role in the consolidation of memories (Tronel and Sara, 2003), decision-making, and risk-reward (Bechara and Damasio, 2005) and error detection (Holroyd et al., 2002). These aspects are significant because memory and decision-making can affect a patient's ability to recall their doctor's recommendations for care. The patient may be more prone to making a risky decision that could impact their health. Consistent with this, Vogels et al. (2007) found that stroke-free HF patients without dementia or depression had a higher occurrence of hyperintensities in prefrontal cortex on magnetic resonance imaging (MRI) scans. Hyperintensities in the human brain reflect lesions produced by demyelination and axonal loss.

Another study performed by Kumar et al. (2011) used an MRI scanner to assess the myelination and axonal status of the brain in 16 heart failure patients and 26 control subjects.

Results indicated that regions with increased axonal diffusivity on the MRI, showed severe changes to brain tissue and axonal loss, and regions with radial diffusivity represented demyelination. The neuronal condition of heart failure patients was a result of ischemic and hypoxic processes that further developed neuropsychological symptoms. These severe changes in diffusion through the damage of nerve fibers, can cause cognitive deficits, including decreased attention, and problems in complex planning, and in short-term memory (Kumar et al., 2011; Almeida & Flicker, 2001; Zuccalá et al., 2005).

Implications of Decision Making in Self-Care

A study conducted in 2019, reported that only 22.3% out of 310 heart failure patients reported good adherences to self-care recommendations. Cognitive impairment in working memory, along with a lack of decision-making abilities, can result in a tendency to not engage in healthy self-care practices. In order to effectively decide to perform these practices, the individual needs to remember to reduce sodium intake, to continually exercise, and to have a healthy sleep schedule. Otherwise, the cognitive impairment will affect their capability to remember, which will lead to worsening of the disease. Ultimately, information processing in patients who are trying to decrease symptoms of heart failure and engage in self-care, involves short-term memory, long-term memory, decision-making, and risk aversion abilities.

As shown in Figure 1 represents the overall human information processing pathway adapted from Wickens and Carswell (2012). The original model's purpose was to explain lower-level motor tasks, but it can also simplify higher-level concepts such as the management and implementation of self-care abilities. At the core of this model, there are five stages of information processing (i.e., sensory input, perception, decision, planning, and integration of

behavior). Patients who are diagnosed with heart failure, receive medical advice from physicians (*input*), which is then perceived and temporarily stored in the short-term memory. Subsequently, the information is compared to past experiences in the long-term memory. At this point, once the information is stored in the long-term memory, it is used as reference for the required action. A decision to engage in consistent self-care behaviors needs to occur prior to gathering all the information (*planning*) and executing the behavior. In case there's an interruption within this processing system, due to a change in cerebral blood flow in people with HF or age-related memory decay, the patient's ability to engage in self-care might be affected (Figure 1).

Current Study

The purpose of this study was to examine the relationship between decision-making and memory function as moderators of self-care in congestive heart failure patients. As a secondary objective, this study investigated the association between age, memory function, decision-making and self-care.

Hypothesis: Poorer memory function and riskier decision-making will be associated with older age and lower heart-failure related self-care.

Hypothesis: Poorer memory function will exacerbate the relationship between decision-making and self-care.

Methods

Participants and Recruitment

The sample was composed predominantly of women (75%) who were white (65%). Additionally, the average participant age was 55.7 years (SD = 11.3) and it ranged from 36 to 77 years old. Most individuals had moderately severe heart failure symptoms (NYHA Class III = 61%). The data for this project came from a more extensive randomized behavioral intervention study of heart failure patients experiencing insomnia. Patients were recruited from the Ohio State Wexner Medical Center (OSWMC), and from Research Match, an NIH-funded website designed to connect researchers and participants. The eligibility criteria included: a diagnosis of HF, NYHA Class I-III symptoms, 18 years of age or older, and English fluency. The exclusionary criteria included: restless leg syndrome, narcolepsy, working at night, seizure disorder, Epworth Sleepiness Scale (ESS) >18, bipolar disorder, and any other psychological factor that may affect the insomnia intervention (Harris, 2018).

Measures

The following three measures of executive cognitive function were administered as part of a brief cognitive battery, reflecting risky decision-making.

Decision-Making Tasks:

Game of Dice Task (GDT) (Brand et al., 2005). The GDT is a computerized measure where individuals follow the rules to demonstrate their decision-making abilities during gains and losses. Participants started at $1000 to play and are asked to generate as much money as possible. They have 18 tosses of a dice, and before rolling the dice, they are required to bet on an

outcome. As participants decide to bet higher numbers of outcomes, their monetary reward decreases. Additionally, if the dice lands in one of the selected numbers, they are rewarded the amount of money associated. However, if it lands in a non-selected number, the amount is deducted from the final reward. Deficits of GDT have shown to be more prominent in impulsive individuals and gamblers (Brand et al., 2005).

Monetary-Choice Questionnaire (MCQ) (Kirby, Petry, & Bickel, 1999): The MCQ is a 27-item questionnaire that measures delayed discounting, which refers to the phenomenon that rewards decline in subjective value as the delay associated with their delivery increases. Further, it assesses whether the individual prefers a smaller-immediate reward over a larger-delayed reward. (e.g., "Would you prefer $54 today or $80 in 30 days?). The questionnaire also groups delayed rewards into 3 categories with 9 items each: small ($25-35), medium ($50-60), and large ($75-85), with a delay of 7-186 days. The procedure is scored by calculating where the participant's answers place him/her among reference discounting curves. Higher values placement among steeper curves indicates higher levels of impulsive behavior.

Iowa Gambling Task (IGT) (Bechara, Damasio, Damasio, & Anderson, 1994): The IGT is a computerized self-administered task assessing differences in decision-making under uncertain situations. The participant chooses one out of four card decks (A, B, C or D). Participants start with $2000 of computerized money and are asked to make profit from it. Unknowingly, decks A and B are considered disadvantageous because they cost the most in the long run. Ultimately, the disadvantageous decks represent risky decision-making. And, decks C and D are advantageous because they result in an overall gain. Participants are asked to complete a total of 100 selection of cards. The first 40 are the learning phase, and the final 60 decks are

considered risky because they should have already experienced the likelihoods of winning and losing in past rounds.

Memory Function Tasks:

Verbal Paired Associates I and II (VPA I and VPA II; Wechsler, 2009). VPA I and VPA II are part of the Wechsler Memory Scale (WMS). VPAI examines the immediate recall of verbally presented word pairs. VPAII assesses the delayed recall measured 20 to 30 minutes after VPAI. For the first VPA, participants are presented with 14 sets of two words; the first word of each pair is read, and they must produce the corresponding word. For VPA II, participants are presented with the same task as the first, but it also includes a recognition and free recall component where participants are asked to remember more words from the first VPA list. VPAII is measured approximately 20 to 30 minutes following VPAI. These tasks are used in clinical research to assess participants' immediate and delayed recall ability. Both tasks are reliable and have good validity, and the WMS provided age-based norms in order to evaluate performance across age groups.

Self-Care Task:

Self-Care of Heart Failure Index (SCHFI)*:* This assessment is a 15-item self-report survey that measures continuation, management, and confidence of self-care practices in patients with HF. Individuals are asked to report how often they practice self-care behaviors specific to congestive heart failure. Additionally, there are three subscales, and it is scored out of 100. Higher scores mean better self-care, while lower scores mean worse self-care abilities. This

measure was used in a large study with 760 heart failure patients and was found to be reliable and valid for research. (Riegel et al., 2004).

Data Analysis

Both SAS Analytics Software for Windows version 9.3 and IBM SPSS Statistics for Macintosh version 24 were used to conduct all analyses for this study. Pearson correlations were used to examine the associations among all variables including age, decision-making, working memory and self-care outcomes. Further, 12 conditional process analyses (i.e., moderated multiple regression) were performed to examine the relationship between 6 independent variable outcomes for decision-making (total money from GDT score, impulsivity scores from MCQ, total advantageous and disadvantageous choices from IGT) and one dependent variable, self-care (total SCFHI score). Concurrently, two moderator variables (total scaled scores from VPAI and VPAII) were used to measure its effect in the relationship between the dependent and independent variables.

Results

Using WMS-IV standards, VPAI scaled scores displayed that 21.7% (n = 5) of the sample had extremely low scores, 43.5% (n = 10) average scores, and 34.8% (n = 8) above average scores for immediate recall, short-term verbal memory. Further, for VPAII 17.2% (n = 4) of the sample scored extremely low scores, 47.8% (n = 11) were average scores, and 34.8% (n=8) achieved above average in long-term verbal memory, or delayed recall (Wechsler, 2009). Risky decision-making is defined as making more disadvantageous choices than advantageous

ones. For the Game of Dice Task, risky decisions were observed in 34.8% (n = 8) and 56.5% (n = 13) in the Iowa Gambling Task.

The Pearson correlations indicated that none of the hypothesized associations were significant (Table 1). Short-term and long-term memory were highly positively correlated (r=0.91, $p < 0.0001$). Further, the total disadvantageous choices and total money earned from GDT were negatively correlated and significant as expected, (r = -0.81, $p < 0.0001$) which demonstrates higher internal validity. Lastly, higher impulsivity levels (large discounting rate from MCQ) had a moderate significant correlation with total disadvantageous choices from the Game of Dice Task.

To investigate whether reduced memory function exacerbates the relationship between decision-making and self-care, the 12 moderated multiple regression analyses were performed using PROCESS on SPSS (Hayes, 2018).

The outcome variable for the first analysis was self-care from the SCHFI, as shown in Figure 2. The predictor variable was decision-making (from total money earned in Game of Dice Task). The moderator variable evaluated for this analysis was the long-term memory from VPAII. Results for this overall model show that there is a small positive trending correlation between the variables ($F(3,19) = 2.95$, $p = 0.06$, $R^2 = 0.32$). Further, GDT was a significant predictor of self-care ($b = 0.0014$, $t(19) = 2.18$, $p = 0.04$). Although long-term memory was not a significant predictor of self-care ($b = 0.93$, $t(19) = 1.71$, $p = 0.10$), the interaction of GDT and LTM reflected a trend ($b = -0.0003$, $t(19) = -1.88$, $p = 0.07$).

As shown in Figure 3, the outcome variable for the second analysis was self-care from the SCHFI. The predictor variable was decision-making (high impulsivity rate from MCQ). The moderator variable evaluated for this analysis was short-term memory from VPAI. According to the results, large impulsivity rate (b= 9.62, t(19) = 0.10, p =0.92) and short-term memory (b= 0.81, t(19)= 1.68, p= 0.11) did not predict self-care. However, the interaction of the two variables indicated a trend (b= -60.48, t(19)= -1.83, p= 0.08). The overall results for this model show that (F(3,19) = 2.46, p = 0.09, R^2 = 0.28) there's a small positive correlation approaching significance.

As shown in Figure 4, the outcome variable for the third analysis was self-care from the SCHFI. The predictor variable was decision-making (average impulsivity rate from MCQ). The moderator variable evaluated for this analysis was short-term memory from VPAI. According to the results, average impulsivity rate (b= 163.07, t(19) = 1.46, p =0.16) and short-term memory (b= 0.42, t(19)= 0.79, p= 0.44) are not significant predictors of self-care, but the interaction reflected a trend (b= -84.01, t(19)= -1.96, p= 0.06). The overall results for this model show a small positive correlation (F(3,19) = 2.44, p = 0.10, R^2 = 0.28) that reflects a trend.

Discussion

The results of this study suggest that poorer memory function exacerbates the relationship between risky decision-making and worse self-care in patients with heart failure. Accordingly, risky decision-making (i.e., greater impulsiveness) was associated with poorer self-care in the presence of poorer memory function. Moreover, individuals who scored lower on STM recall had higher levels of impulsivity (lower DM) and lower self-care scores. Overall, the results of the analyses were not statistically significant. One explanation could be the lack of statistical

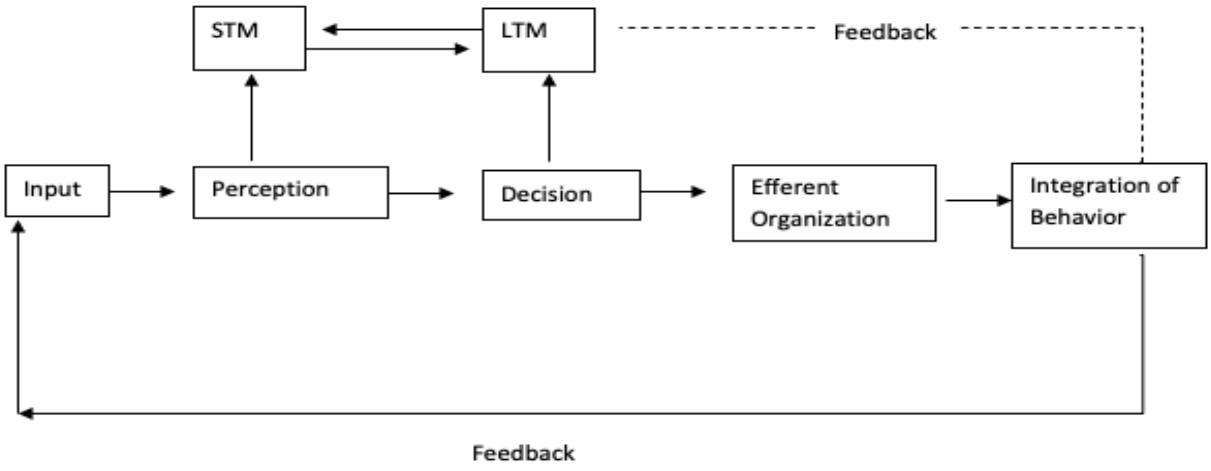
power due to the limitation in recruiting heart failure participants (N = 23). Although these findings do not meet statistical significance, they may still reflect clinically relevant phenomenon and warrant further consideration regarding individuals with heart-failure.

The present study found no significant association between memory function (i.e. short-term immediate recall, and long-term delayed recall), decision-making, age and self-care. Results from this current study contrast findings from other studies that have found a relationship between decision-making and self-care (Tsai et al., 2014). However, this conclusion was derived from a sample of 71 inpatients, with an additional measure for self-care, the Dutch Heart Failure Knowledge Scale. This assessment was used to consider how well they retained information regarding HF related symptoms. Ultimately, the current study did not find significant statistical evidence to support the hypothesis that reduced memory function and riskier decision-making were associated with older age and poorer heart-failure related self-care. In addition, there was only a statistical trend in support of the hypothesis that memory function would exacerbate the relationship between decision-making and self-care.

Future directions for studies related to the wellbeing of patients with heart-failure could be to explore the relationship among short-term memory, attention-span and decision-making abilities. It would be recommended to have a larger sample size, as it affects the statistical power. Further, researchers could also design an intervention study to improve the short-term and long-term memory of individuals with heart failure, as that might diminish the negative influence of risky decision-making on self-care behaviors.

Figure 1

Information Processing Model Adapted from Wickens and Carswell (2012)



Note: In this figure, STM stands for short-term memory and LTM stands for long-term memory.

Figure 2

Self-Care as a Function of Long-Term Memory and Decision-Making

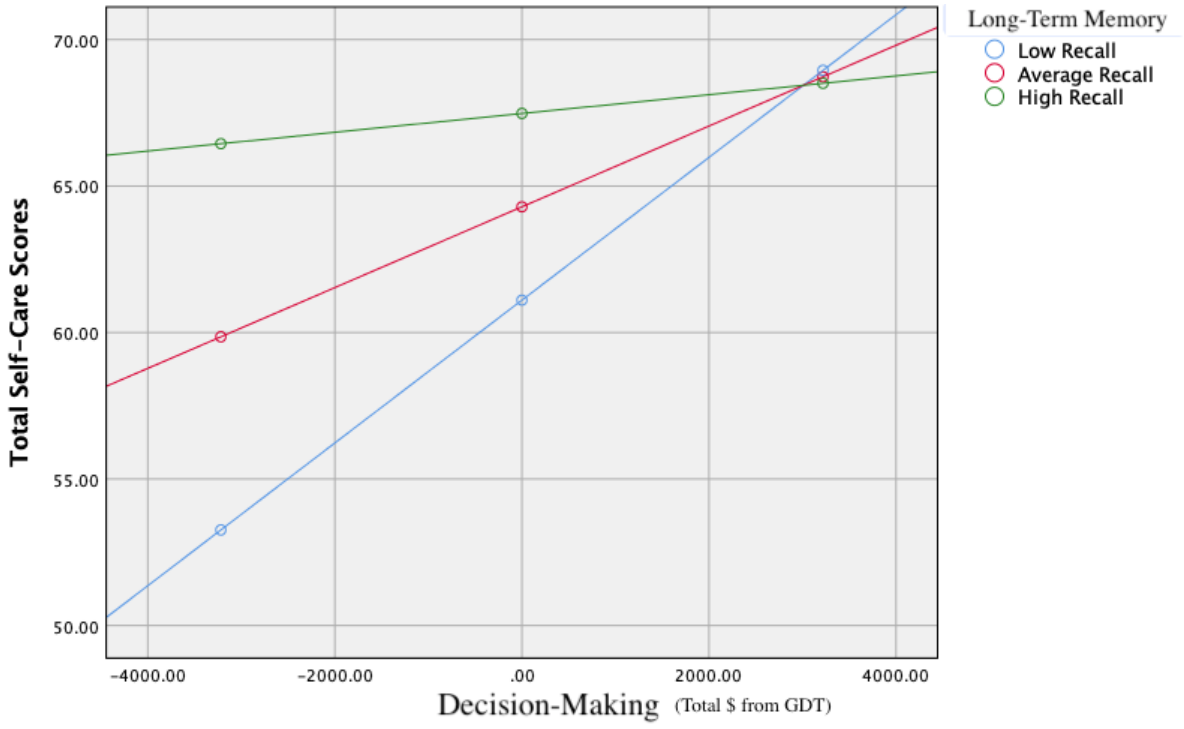


Figure 3

Self-Care as a Function of Short-Term Memory and High Impulsivity Rate

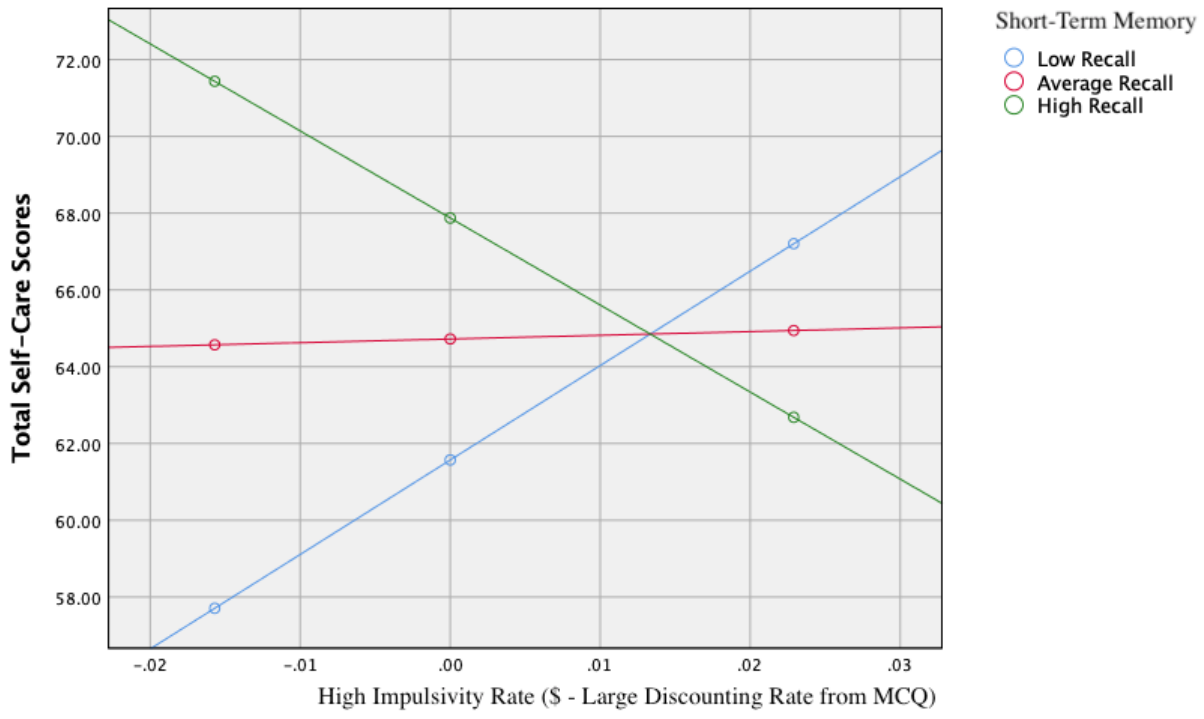


Figure 4

Self-Care as a Function of Short-Term Memory and Average Impulsivity Rate

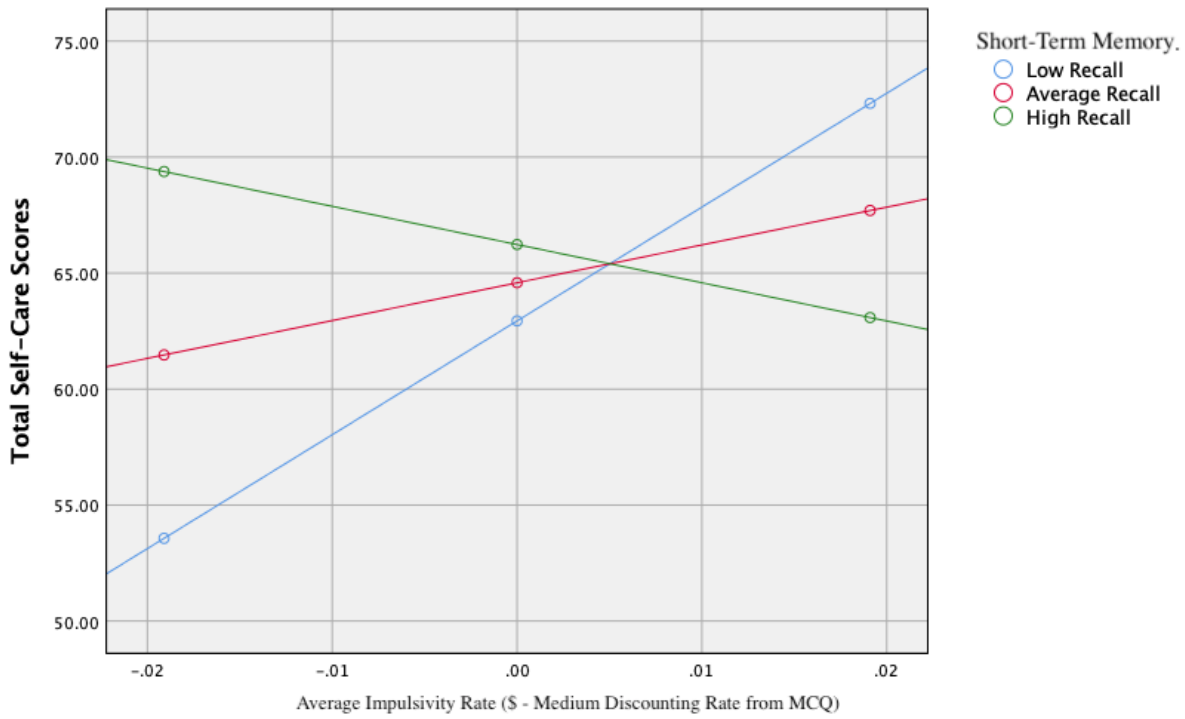


Table 1

Pearson Correlation of Age, Self-Care Score, Memory, and Decision-Making Variables

Correlations

		Age	Self Care	Short-Term Memory	Long-Term Memory	Money Total	Small Impulsivity Level	Medium Impulsivity Level	Large Impulsivity Level	Total Disadvantageous Choices	Advantageous-Disadvantageous Choices
Age	Pearson Correlation	1	-.261	.174	.168	-.267	.069	.162	.180	.100	-.100
	Sig. (2-tailed)		.229	.426	.445	.218	.755	.460	.412	.649	.649
	N	23	23	23	23	23	23	23	23	23	23
Self Care	Pearson Correlation	-.261	1	.345	.324	.239	-.050	.104	-.189	-.057	.057
	Sig. (2-tailed)	.229		.106	.131	.273	.822	.636	.388	.796	.796
	N	23	23	23	23	23	23	23	23	23	23
Short-Term Memory	Pearson Correlation	.174	.345	1	.905**	-.126	-.268	-.033	-.012	.003	-.003
	Sig. (2-tailed)	.426	.106		.000	.566	.216	.881	.958	.989	.989
	N	23	23	23	23	23	23	23	23	23	23
Long-Term Memory	Pearson Correlation	.168	.324	.905**	1	-.151	-.175	-.030	-.013	.077	-.077
	Sig. (2-tailed)	.445	.131	.000		.493	.425	.892	.953	.729	.729
	N	23	23	23	23	23	23	23	23	23	23
Money Total	Pearson Correlation	-.267	.239	-.126	-.151	1	.056	.090	-.546**	-.808**	.808**
	Sig. (2-tailed)	.218	.273	.566	.493		.800	.682	.007	.000	.000
	N	23	23	23	23	23	23	23	23	23	23
Small Impulsivity Level	Pearson Correlation	.069	-.050	-.268	-.175	.056	1	.372	.188	.041	-.041
	Sig. (2-tailed)	.755	.822	.216	.425	.800		.080	.390	.851	.851
	N	23	23	23	23	23	23	23	23	23	23
Medium Impulsivity Level	Pearson Correlation	.162	.104	-.033	-.030	.090	.372	1	.332	-.006	.006
	Sig. (2-tailed)	.460	.636	.881	.892	.682	.080		.121	.980	.980
	N	23	23	23	23	23	23	23	23	23	23
Large Impulsivity Level	Pearson Correlation	.180	-.189	-.012	-.013	-.546**	.188	.332	1	.530**	-.530**
	Sig. (2-tailed)	.412	.388	.958	.953	.007	.390	.121		.009	.009
	N	23	23	23	23	23	23	23	23	23	23
Total Disadvantageous Choices	Pearson Correlation	.100	-.057	.003	.077	-.808**	.041	-.006	.530**	1	-1.000**
	Sig. (2-tailed)	.649	.796	.989	.729	.000	.851	.980	.009		.000
	N	23	23	23	23	23	23	23	23	23	23
Advantageous-Disadvantageous Choices	Pearson Correlation	-.100	.057	-.003	-.077	.808**	-.041	.006	-.530**	-1.000**	1
	Sig. (2-tailed)	.649	.796	.989	.729	.000	.851	.980	.009	.000	
	N	23	23	23	23	23	23	23	23	23	23

Note: **a) WM:** short-term memory scores from Verbal Paired Associates, long-term memory scores from Verbal Paired Associates. **b) DM:** total advantageous choices from Iowa Gambling Task, total disadvantageous choices from Iowa Gambling Task, total money earned from Game of Dice Task, small impulsivity level from Monetary Choice Questionnaire, medium impulsivity level Monetary Choice Questionnaire, large impulsivity level. The top number is the correlation coefficient, the bottom is the p-value and number of participants (N=13).

Table 2

Moderated Multiple Regression: Long-Term Memory Moderates Decision-Making in Self-Care of Patients with Heart Failure

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OUTCOME VARIABLE:
 SCHFI_TO

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .5637      .3177    73.5401     2.9492     3.0000    19.0000      .0590

Model
              coeff         se          t          p       LLCI       ULCI
constant    64.2920     1.8069    35.5810      .0000    60.5098    68.0742
MONEY_TO      .0014      .0006     2.1812      .0419      .0001      .0027
VPAII_DR      .9272      .5413     1.7130      .1030     -.2057     2.0602
Int_1        -.0003      .0002    -1.8874      .0745     -.0006      .0000

Product terms key:
 Int_1    :        MONEY_TO x        VPAII_DR

Covariance matrix of regression parameter estimates:
           constant   MONEY_TO   VPAII_DR      Int_1
constant     3.2650     -.0001      .0149      .0000
MONEY_TO     -.0001      .0000      .0000      .0000
VPAII_DR      .0149      .0000      .2930      .0000
Int_1         .0000      .0000      .0000      .0000

Test(s) of highest order unconditional interaction(s):
       R2-chng          F        df1        df2          p
X*W      .1279     3.5623     1.0000    19.0000      .0745
----------
    Focal predict: MONEY_TO (X)
          Mod var: VPAII_DR (W)
```

Table 3

Moderated Multiple Regression: Short-Term Memory Moderates Decision-Making in Self-Care of Patients with Heart Failure

```
OUTCOME VARIABLE:
 SCHFI_TO

Model Summary
          R       R-sq        MSE          F        df1        df2          p
        .53        .28      77.77       2.44       3.00      19.00        .10

Model
              coeff         se          t          p       LLCI       ULCI
constant      64.58       1.84      35.07        .00      60.73      68.44
MedK         163.07     112.07       1.46        .16     -71.50     397.65
VPAI_Sca        .42        .53        .79        .44       -.69       1.54
Int_1        -84.01      42.88      -1.96        .06    -173.75       5.74

Product terms key:
 Int_1    :        MedK     x        VPAI_Sca

Covariance matrix of regression parameter estimates:
           constant       MedK   VPAI_Sca      Int_1
constant       3.39      -5.39        .02       4.33
MedK          -5.39   12558.95     -10.47   -2289.00
VPAI_Sca        .02     -10.47        .28       9.67
Int_1          4.33   -2289.00       9.67    1838.34

Test(s) of highest order unconditional interaction(s):
       R2-chng          F        df1        df2          p
X*W        .15       3.84       1.00      19.00        .06
----------
    Focal predict: MedK     (X)
          Mod var: VPAI_Sca (W)
```

Note: MedK stands for Medium Impulsivity Level, a decision-making outcome. VPAI stands for Verbal Paired Associates I, a measure for short-term memory function.

Table 4

Moderated Multiple Regression: Short-Term Memory Moderates Decision-Making in Self-Care of Patients with Heart Failure

```
OUTCOME VARIABLE:
 SCHFI_TO

Model Summary
          R       R-sq        MSE          F        df1        df2          p
        .53        .28      77.60       2.46       3.00      19.00        .09

Model
              coeff         se          t          p       LLCI       ULCI
constant      64.72       1.84      35.23        .00      60.88      68.57
LargeK         9.62      94.89        .10        .92    -188.99     208.24
VPAI_Sca        .81        .48       1.68        .11       -.20       1.82
Int_1        -60.48      33.10      -1.83        .08    -129.76       8.80

Product terms key:
 Int_1    :        LargeK   x        VPAI_Sca

Covariance matrix of regression parameter estimates:
           constant     LargeK   VPAI_Sca      Int_1
constant       3.37      -1.58        .00       1.09
LargeK        -1.58    9003.77       -.62   -1584.76
VPAI_Sca        .00       -.62        .23        .75
Int_1          1.09   -1584.76        .75    1095.49

Test(s) of highest order unconditional interaction(s):
       R2-chng          F        df1        df2          p
X*W        .13       3.34       1.00      19.00        .08
----------
    Focal predict: LargeK   (X)
          Mod var: VPAI_Sca (W)
```

Note: LargeK stands for Large Impulsivity Level, a decision-making outcome. VPAI stands for Verbal Paired Associates I, a measure for short-term memory function.

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Appendix A – Study Questionnaires

SELF-CARE OF HEART FAILURE INDEX

All answers are confidential.

Think about how you have been feeling in the last month or since we last spoke as you complete these items.

SECTION A:

Listed below are common instructions given to persons with heart failure. How routinely do you do the following?

	Never or rarely	Sometimes	Frequently	Always or daily
1. Weigh yourself?	1	2	3	4
2. Check your ankles for swelling?	1	2	3	4
3. Try to avoid getting sick (e.g., flu shot, avoid ill people)?	1	2	3	4
4. Do some physical activity?	1	2	3	4
5. Keep doctor or nurse appointments?	1	2	3	4
6. Eat a low salt diet?	1	2	3	4
7. Exercise for 30 minutes?	1	2	3	4
8. Forget to take one of your medicines?	1	2	3	4
9. Ask for low salt items when eating out or visiting others?	1	2	3	4
10. Use a system (pill box, reminders) to help you remember your medicines?	1	2	3	4

16. Think of a remedy you tried the last time you had trouble breathing or ankle swelling,

(Circle **one** number)

	I did not try anything	**Not Sure**	**Somewhat Sure**	**Sure**	**Very Sure**
How sure were you that the remedy helped or did not help?	0	1	2	3	4

SECTION C:

In general, how confident are you that you can:

	Not Confident	**Somewhat Confident**	**Very Confident**	**Extremely Confident**
17. Keep yourself free of heart failure symptoms?	1	2	3	4
18. Follow the treatment advice you have been given?	1	2	3	4
19. Evaluate the importance of your symptoms?	1	2	3	4
20. Recognize changes in your health if they occur?	1	2	3	4
21. Do something that will relieve your symptoms?	1	2	3	4
22. Evaluate how well a remedy works?	1	2	3	4

SECTION B:

Many patients have symptoms due to their heart failure. Trouble breathing and ankle swelling are common symptoms of heart failure.

In the past month, have you had trouble breathing or ankle swelling? Circle one.

0) No

1) Yes

11. If you had trouble breathing or ankle swelling in the past month…?

(Circle **one** number)

	Have not had these	I did not recognize it	Not Quickly	Somewhat Quickly	Quickly	Very Quickly
How quickly did you recognize it as a symptom of heart failure?	N/A	0	1	2	3	4

Listed below are remedies that people with heart failure use. If you have trouble breathing or ankle swelling, how likely are you to try one of these remedies?

(Circle **one** number for each remedy)

	Not Likely	Somewhat Likely	Likely	Very Likely
12. Reduce the salt in your diet	1	2	3	4
13. Reduce your fluid intake	1	2	3	4
14. Take an extra water pill	1	2	3	4
15. Call your doctor or nurse for guidance	1	2	3	4

Monetary Choice Questionnaire (MCQ)

Monetary-Choice Questionnaire

For each of the next 27 choices, please indicate which reward you would prefer: the smaller reward today, or the larger reward in the specified number of days.

1. Would you prefer $54 today, or $55 in 117 days?

2. Would you prefer $55 today, or $75 in 61 days?

3. Would you prefer $19 today, or $25 in 53 days?

4. Would you prefer $31 today, or $85 in 7 days?

5. Would you prefer $14 today, or $25 in 19 days?

6. Would you prefer $47 today, or $50 in 160 days?

7. Would you prefer $15 today, or $35 in 13 days?

8. Would you prefer $25 today, or $60 in 14 days?

9. Would you prefer $78 today, or $80 in 162 days?

10. Would you prefer $40 today, or $55 in 62 days?

11. Would you prefer $11 today, or $30 in 7 days?

12. Would you prefer $67 today, or $75 in 119 days?

13. Would you prefer $34 today, or $35 in 186 days?

14. Would you prefer $27 today, or $50 in 21 days?

15. Would you prefer $69 today, or $85 in 91 days?

16. Would you prefer $49 today, or $60 in 89 days?

17. Would you prefer $80 today, or $85 in 157 days?

18. Would you prefer $24 today, or $35 in 29 days?

19. Would you prefer $33 today, or $80 in 14 days?

20. Would you prefer $28 today, or $30 in 179 days?

21. Would you prefer $34 today, or $50 in 30 days?

22. Would you prefer $25 today, or $30 in 80 days?

23. Would you prefer $41 today, or $75 in 20 days?

24. Would you prefer $54 today, or $60 in 111 days?

25. Would you prefer $54 today, or $80 in 30 days?

26. Would you prefer $22 today, or $25 in 136 days?

27. Would you prefer $20 today, or $55 in 7 days?

Iowa Gambling Task (IGT Computerized Measure)

	'Disadvantageous' decks		'Advantageous' decks	
	A	B	C	D
Gain per card	100	100	50	50
Loss per 10 cards	1250	1250	250	250
Net per 10 cards	-250	-250	+250	+250

Game of Dice Task (GDT Computerized Measure)